# COMPETENCY MANAGEMENT

**A THESIS**

***Submitted by***

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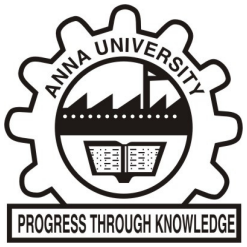


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# CHAPTER 2

# LITERATURE SURVEY

## 2.1 LITERATURE SURVEY

Towards the research objectives stated in Section 1.5, detailed literature survey was carried out in the following areas:

- Potential, competency and assessment at individual level
- Competency based education and training
- Enterprise management systems and competence of organizations

## 2.2 POTENTIAL, COMPETENCY AND ASSESSMENT

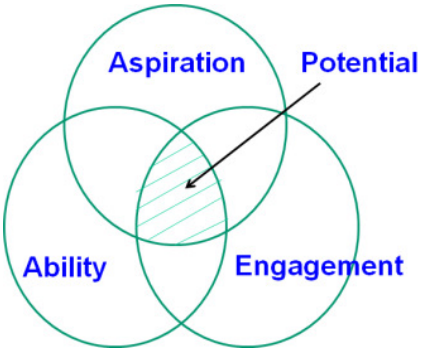
Research shows that organizations that successfully identify and develop high-potential talent will enjoy short and long-term advantages over their competitors (Council 2011). The trend to use competency-based approaches in education and training, assessment, and development of workers is a more recent emergence (Ennis 2008). Developing people in an organizational context for their current and future roles require a better understanding of :

- Potential of people
- Definition and characteristics of competency
- Assessment of innate ability

### 2.2.1 Potential of People

The Corporate Leadership Council (CLC) has been doing pioneering research on strategies that build employee potential. Using quantitative research, CLC developed a framework to identify high potential employees and develop them to realize their full potential. High potential employee is someone with the Aspiration, Ability and Engagement (Council 2011). The overlap of alignment of these three factors determines the potential of people as shown in the Figure 2.1.

Aspiration is to "rise and succeed in more senior and critical positions" and also about advancement, recognition, financial rewards and the overall enjoyment that one seeks to achieve in their life or career (Council, 2011). The ferment in management will continue until we build organizations that are more consistent with man's higher aspirations beyond food, shelter and belonging (Senge 1990). The meaning we create at work can make life feel rich and full regardless of our external circumstances or give us the courage to change our external circumstances. When we find meaning at work, we find meaning in life (Ulrich & Ulrich 2010). Employees who find meaning at work are more competent, committed and contributing, which in turn leads to increased customer commitment and better financial results for the company (Ulrich & Ulrich, 2010).




Source: (Council, 2011)

**Figure 2.1 Potential of employees**

Ability is a combination of the innate characteristics and learned skills that an employee uses to carry out his/her day-to-day work (Council, 2011). Innate characteristics include mental/cognitive agility and Emotional Intelligence. Underneath our role, profession, appearance, or observable talents are what psychologists call signature strength; the character traits and values most central to who we are (Ulrich & Ulrich, 2010). Learned Skills include technical/functional skills and interpersonal skills (Council, 2011).

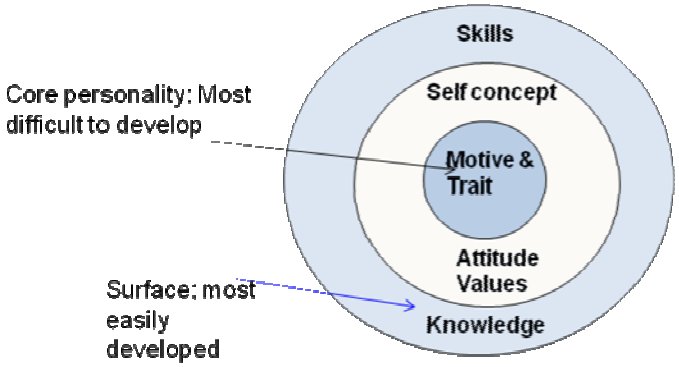
Engagement consists of four elements in an organizational context - Rational commitment, emotional commitment, discretionary efforts and intent to stay on with the job/organization (Council 2011). Emotional commitment is the extent to which employees value, enjoy, and believe in their organizations. Rational commitment is the extent to which employees believe that staying with their organizations is in their self-interest. Discretionary effort is the employees' willingness to go "above and beyond" the call of duty. Intent to stay is about employee desire to stay with the organization(Council 2011). At an individual level, engagement is about actively purusing actions towards the personal or career goals.

### 2.2.2 Definition and Characteristics of Competency

Organizations that understand the characteristics of those who get the best results are better positioned to recruit, select, develop, reward, and promote the most successful people and can develop a competitive advantage (Rothwell 2011). A competency is the capability of applying or using knowledge, skills, abilities, behaviors, and personal characteristics to successfully perform critical work tasks, specific functions, or operate in a given role or position. Personal characteristics may be mental/intellectual/ cognitive, social/emotional/attitudinal, and physical/psychomotor attributes necessary to perform the job (Dubois 1993). Competencies are "sets of behaviors that are instrumental in the delivery of desired results" (SHL 2006).

Competency is an underlying characteristic of an individual that is causally related to criterion – referenced effective and/or superior performance in a job or situation (Spencer 1993).

Underlying characteristic means the competency is a fairly deep and enduring part of a person's personality and can predict behavior in a wide variety of situations and job tasks. Causally related means that a competency that causes or predicts behavior and performance. 'Criterion-referenced' means that the competency actually predicts who does something well or poorly, as measured on a specific criterion or standard (Spencer 1993). Superior performance is defined statistically as one standard deviation above average performance, roughly the level achieved by the top one person out of ten in a given working situation. Effective performance usually means a 'minimally acceptable' level of work, the lower cut-off point below which an employee would not be considered competent to do the job (Spencer 1993).




Source: (Spencer, 1993)

**Figure 2.2 Characteristics of competency**

Competency include five characteristics - Motive, Traits, Self-concept, Knowledge and Skills (Spencer 1993) as shown in Figure 2.2.

- Motive is a thing a person consistently thinks about or wants that cause action. Motives "drive, direct, and select" behaviour towards certain actions or goals and away from others. For example, achievement motivated people consistently set challenging goals for themselves, take personal responsibility for accomplishing them, and use feedback to do better.

  An individual's specific needs are acquired over time and shaped by one's life experiences. There are three types of motivational needs – achievement motivation, authority/power motivation, affiliation motivation. A person's motivation and effectiveness in certain job functions are influenced by these three needs (McClelland 1961). According to McClelland, every motive is a learned one, and only two are innate, namely, striving for pleasure and seeking to avoid displeasure or pain (Mamoria 1994)

- Traits are physical characteristics and consistent responses to situations or information. Example: Reaction time and good eyesight are physical trait competencies of combat pilots.

- Self-Concept is a person's attitude, values or self-image. Example: Self-confidence, a person's belief that he or she can be effective in almost any situation is part of that person's concept of self. A person's values are respondent or reactive motives that predict what he or she will do, in a given situation

- Knowledge is about the information a person has in specific content areas. Example: A surgeon's knowledge is specific to his domain. Scores on knowledge fails to predict work

performance because they fail to measure knowledge and skills in the ways they are actually used on the job.

- Skill is the ability to perform a certain physical or mental task. Example: A dentist's physical skills to fill a tooth without damaging the nerve; a computer programmer's ability to organize 50,000 lines of code in logical order.

Knowledge and skill competencies tend to be visible, and are relatively surface characteristics of people. Self-concept, trait, and motive competencies are more hidden, "deeper" and central to one's personality. Surface knowledge and skill competencies are relatively easy to assess and developed through education and training. Core motive and trait competencies at the core of the personality are more difficult to assess and develop, and it is equivalent to innate ability in the CLC model of potential. Self concept competencies lie in between. Attitudes and values such as self-confidence can be changed by training, psychotherapy and/or positive developmental experiences, albeit with more time and difficulty. Hence, organizations should assess motives and trait competencies as the basis for selection and teach or learn the knowledge and skills required to do specific jobs (Spencer 1993).

### 2.2.3 Assessment of Innate Ability

There are many standard selection tools available in the market which are used by organizations. In the past, IQ tests were used, as IQ was considered to be extremely important. Subsequently, organizations began to use other tools such as technical tests, aptitude tests and psychometric tests. Even with this approach, the choice of the tools is often arbitrary and they do not map the candidate with the role in question. Employers may have a right to select bond salesmen who have gone to the right schools because they do

better, but psychologists do not have a right to argue that it is their intelligence that makes them more proficient in their jobs (McClelland 1973).

Personality is an abstraction or hypothetical construction from or about behaviour whereas behaviour itself consists of observable events (Mischel 2013). Personality psychology makes inferences about an individual's personality, focusing on behavioural observations as signs of underlying attributes or processes within the person that serves as clues to his/her peronality. Trait can be measured as the differences between the directly observable behaviour or characteristics of two or more indivduals on a defined dimension (Mischel 2013). Trait is a dynamic trend of behaviour which results from the integration of numerous specific habits of adjustment, and which expresses a characteristic mode of the individual's reaction to his/her surroundings (Allport 1936).

Allport and his colleague HS Odbert scanned the dictionary for words that could be traits, found about 18,000, then pared that down to 200 traits after eliminating synonyms (Ciccarelli & Meyer 2008). Using factor analysis, Raymond Cattel discovered 16 source traits and developed his assessment questionaire which is called *The sixteen Personality Factor Questionaire (16 PF).* Personality assessment methods commonly used are interviews, projective tests, behavioural assessments, personality inventories (Ciccarelli & Meyer 2008). Trait theorists are typically more interested in personality descriptions. They tend to use an assessment known as 'Peronality inventory', a questionaire that has a standard list of questions and only requires certain specific answers, such as 'yes' , 'no' and 'can't decide'. Few examples of peronaility inventories are 16 PF (Sixteen factor peronality questionaire), MBTI (Myers – Briggs Type Indicator), and California Psychological Inventory.

An asessment centre is a structured combination of assessment techniques that are used to provide a wide-ranging, holistic assessment of each participant (Robertson et al 2002). The primary use of assessment centres has been to identify individuals who have the capacity and potential to assume broader and more challenging job responsibilities (McClelland 1995). Although the assessment centres used in different organizations differ widely in terms of content and organization, there are several features that nearly all assessment centres share in common that are distinctive to this approach (Robertson et al 2002). They are:

- Assessment of small groups of participants simultaneously.
- Each participant's behaviour is observed and evaluated by a number of different assessors. The final ratings for assessment represent the team's consensus.
- Assessment centre activities might include multiple methods such as ablity tests, personality tests, situational tests, interviews, peer evaluation, and performance tests in order to capitalise the strengths of each individual test and overcome the limitations of the tests.
- The use of situational tests such as in-basket, role play and the leaderless group discussion tests.
- Assessment along multiple dimensions: each exercise in the assessment center typically provides information relevant to one or more dimensions, and rating of specific dimensions (e.g energy) might reflect data obtained from several different exercises.

Using a competency model to develop behaviour-based interview protocols and assessment tools can ensure the right fit of an individual when

selecting and hiring for a position (McClelland 1998). The concept of 'Appreciative Inquiry' (AI) can be adopted for developing behavioral event interview. Appreciative Inquiry is the cooperative, coevolutionary search for the best in people, their organizations and the world around them. What came out of the development of AI is that human systems grow in the direction of what they persistently ask questions about, and this propensity is strongest and most suitable when the means and the ends of the inquiry are positively correlated (Cooperrider & Whitney 2005). One of the basic tenets of AI is social constructionism ( for individuals it is called constructivism). People construct their life through their communication. When people identify and own their 'life giving forces' build their hopes and create their desired future (Jane Magruder 2001).

### 2.2.4 Summary of Insights from Section – 2.1

Based on the survey of literature on potential, competency, and assessment methodologies, the following insights were drawn for research.

- Innate ability, which is about personality characteristics such as traits, motive and attitude can be used for selection.
- Assessment centre is most appropriate methdology for assessing innate ability.
- If people articulate aspiration in terms of career or life goal, they will be engaged better to learn the knowledge and skills.

## 2.3 COMPETENCY BASED EDUCATION AND TRAINING

Competencies, or individual characteristics, were recognized as significant predictors of employee performance and success, equally as important as an individual's academic aptitude and knowledge content as

indicated by tests scores or results (McClelland 1973). Many educators agree that a major step in this direction will be to anchor engineering education in a more holistic perspective (Schaefer & Panchal 2012). There ought to be superior alignment between societal needs, technologies, cross disciplinary integration and associated educational activities.

The Indian higher education system ails from significant structural shortcomings and faces huge challenges in meeting the current and future expectations (Ahuja 2012). More emphasis has to be laid on quality improvement measures in the technical education system through adoption of proactive and innovative strategies for meeting global challenges posed by ever increasing and rapidly changing technological advances. The task of producing high quality graduates has become more difficult due to the limitations on the resources available, restrictions on fee hikes in technical institutes and dwindling government support (Ahuja 2012). Very little effort was exerted by the engineering educationalists to align the requirements of organizations with the capabilities of engineers supplied. There are several categories of universities and affiliated engineering institutes, hence there is a lack of a unified approach to curriculum and pedagogy for engineering institutions (Thandapani 2012). Thanks to the plentiful jobs for generations of engineering graduates in many organizational sectors, particularly in the Information Technology sector, engineering education has been found appealing to a major portion of Indian student community (Thandapani 2012). This led to the proliferation of a large number private engineering institutes and deemed universities.

The effectiveness and efficiency of any educational programme is largely dependent on the philosophy of the curriculum design followed. If specific occupations are not focused in the curriculum design philosophy, the products of engineering technology programmes may not be ‘work-ready’ and then it becomes necessary to consider ‘occupation-specific competencies’ in

the curriculum designs (Earnest 2005). Competency-based education has remained essentially unchanged since the 1960s with regard to features such as focus on outcomes, greater workplace relevance, outcomes as observable competencies, assessments as judgments of competence, improved skills recognition, improved articulation and credit transfer (Brown 2000). Competency based curriculum defines new objectives in the learning process, enhances learning environments and shifts the concept of learning from accumulation of knowledge to learning as a permanent attitude towards knowledge acquisition (Edwards et al 2009).

The competency based approach needs to bring clarity on how the curriculum focusses on competencies in terms of what level do students learn and practice them, what teaching strategies and assignments are used, what assessments (methodologies, resources and instruments) are chosen for the students to master the competences, and how to develop and improve indicators in order to achieve the learning outcomes (Edwards et al 2009). It is now a common practice for undergraduate curricula to be finely balanced between disciplinary knowledge and the more universal generic skills. Such demands come from stakeholders in higher education (Walczak et al 2013). Engineering education needs to create a *holistic engineers' profile* with a system perspective view, an interdisciplinary approach, project-based learning strategy, and a symbiotic relationship between research, education and innovation (Secundo et al 2013). The most important active teaching/learning methodologies include Cooperative learning, Peer-assisted learning, Problems/Projects based learning, Work-based learning and Reflexive learning (Ponsa et al 2009). The big challenge boils down to educating students in the art of learning how to learn and to empower them to take charge of their own education within the context of an ever-increasing amount of subject matter to be comprehended (Schaefer & Panchal 2012).

The theory of collaborative learning is tied together by a number of important assumptions about learners and learning processes (Schaefer & Panchal 2012) which include:

- Learning is an active, constructive process in which learners create new knowledge by using, integrating and reorganizing their prior knowledge
- Learning depends on a rich context, which influences the success of learning significantly
- Learners are diverse in terms of background, knowledge, experience and learning styles
- Learning is inherently social, which makes student interaction an important part of education

Demands from stakeholders in higher education and, in particular, from the two most interested groups: employers, wish for the best prepared workers, and students, who wish for the best employment. Research on trends and future challenges on manufacturing education focused on profile, content, learning and strategy (Secundo et al 2013) as shown in Table 2.1.

**Table 2.1 Trends and future challenges for manufacturing education**

| Item | Trends | Challenges |
|---|---|---|
| Who: Profile | Manufacturing education needs to create a ‘‘holistic” engineer profile with a system perspective view | The engineer of the future should possess business and entrepreneurial capabilities to succeed in the sustainable and knowledge - based society |

| | | |
|---|---|---|
| What; Content | Manufacturing education needs to adopt an interdisciplinary approach to overcome the traditional separations among the disciplines | Universities need to design and manage learning patterns to dynamically integrate different areas of specialization ranging from business to technology management |
| How: Learning approach | Manufacturing education now has to go beyond the passive learning approach and to be project and action oriented. | Universities need to rethink teaching and learning approaches to provide future engineers to proactively manage complex problems and systems. |
| How: Strategy | The education system has to move with respect to complex networks and symbiotic relationship and integration among research, education and innovation. | Manufacturing education can only benefit from partnership and networking in the industrial context, to overcome the separation between education and research. |

Source: (Secundo et al 2013)

Owing to market competition and tight resources in today's world, industries have set high requirements for engineering graduates (Fang 2012). These requirements involve not only technical skills, such as proficiencies and a broad knowledge in a specific academic discipline, but also professional skills, such as effective communication, teamwork, leadership, business knowledge, entrepreneurship, and project management. To address the above problems and issues, a variety of instructional approaches, such as project-based learning, active learning, and collaborative learning have been developed and implemented in various educational settings.

There is a need to change the practice of engineering and engineering education due to general technological advances, pervasive use of information technology, modification of value-adding chains, the vast array of new materials and processes that broaden engineers' design space, the need for teamwork and the fast pace of change calling for lifelong learning (Edwards et al 2009). Some of the requirements to build capacity for

innovation include transformation of large private companies and creating an incentive system for institutions of higher learning that is more consistent with the strengthening of industrial innovation capabilities. The education and training programmes in companies as well as academic programmes must be aligned to establish a continuum of competencies relevant to career lifecycles of employees starting with the entry level. Hence, the curriculum design philosophy for academic programmes as well as for training programmes in the companies must address occupation-specific competencies. Towards this the literature survey was carried out to cover the following areas:

- Challenges and trends in engineering education, including benchmarking of universities in UK and US
- Leaders' thoughts on education to get a the holistic perspective
- Bloom's Taxonomy, which provides focussed knowledge and cognitive process dimensions of learning outcomes
- Instructional design that can translate the learning outcomes into content, teaching/learning/evaluation methodologies along with Bloom's Taxonomy

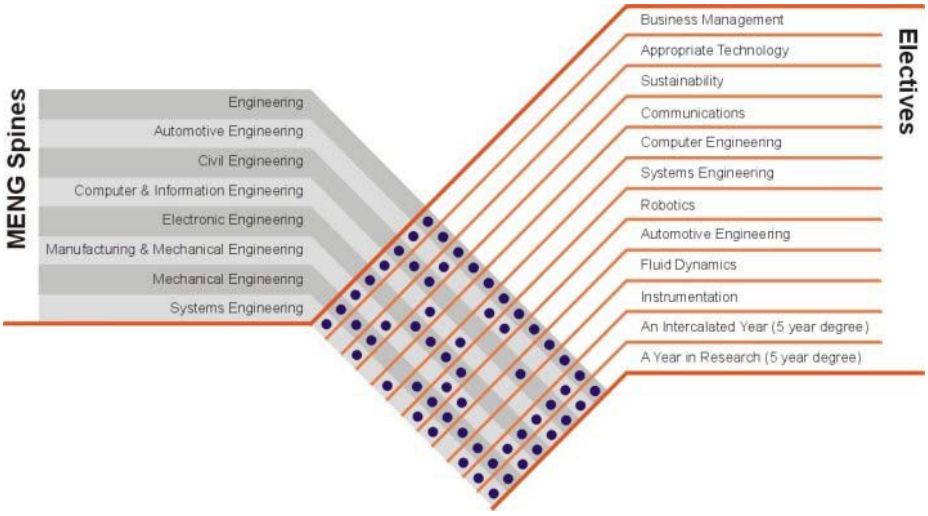
Design, development and manufacture of automotive products require a strong foundation in domain knowledge and lifelong learning to keep pace with rapid technological developments (Krishnan R T 2010).

### 2.3.1 University of Warwick, UK

The undergraduate programme in engineering aims to develop students' knowledge and understanding of professional engineering based around five themes: Science, Analysis, Design, Manufacture and Construction

and Business" (University 2007/2008). Objectives are clearly stated which the students will be able to demonstrate at the end of the programme as shown in Appendix A.2.1. The programme also aims to develop a range of key skills relevant to professional engineering and to other occupations as shown in Appendix A.2.1. The curriculum is aligned to deliver these objectives.

The Master of Engineering programme (MEng) aims to provide the educational base required for a Chartered Engineer, in accordance with the Engineering Council UK Spec. The programme is designed to prepare students for a successful career in engineering by providing interdisciplinary awareness and intellectual challenge in the early years, followed by specialization in the later years. In the first two years the programme is kept generic with a few elective options and several options are provided for the students to decide their specialization (Figure 2.3).




Source: (University, 2007/2008)

**Figure 2.3 MEng spine and elective combinations**

A student's learning experience includes lectures, tutorials/ seminars/ practical work, site visits, fieldwork and private study. There is an

emphasis on the personal tutor system and in the first-year, small-group tutorials form part of the formal teaching programme. In line with the requirements of the Quality Assurance Agency, the university offers an enhanced individual project that commences in Year 3 and is completed in Year 4 and a Group Project in Year 4. Group Projects draw upon the skills and knowledge of students from more than one discipline to tackle a project that may be provided by the industry or related to research within the university.

Scheduled teaching generally amounts to some 15 hours per week. As a guide though, students should be prepared to spend on average at least some 30 hours per week, and to undertake some private study in the vacations. Technical content is presented in lectures, with emphases and applications from the lecturer's knowledge and experience. The objective is for lectures to aid understanding and provide the foundation for other learning experiences. Practical work and projects develop knowledge and understanding, by studies of behavior and by applications in analysis, design and manufacture/construction, largely set within the industrial and commercial context. These include skills training, experiments, CAD, and, where appropriate, field or work-based activities. Practical work provides the opportunity of seeking assistance and advice from the academic staff and demonstrators in the laboratory. Through performing and reporting such work and through assessment feedback, the students develop skills in creative thinking, problem solving and criticism, as also in written and oral communication. Deadlines develop the ability to perform to time, something essential in professional engineering and many other walks-of-life. Experimental and field activities generally take place in groups, giving the students the opportunity to develop interpersonal and team-working skills. Project work comprises open-ended individual or group assignments undertaken over an extended period but with strict deadlines; such work assists in developing learning capability, research skills and self-reliance, in addition to other transferable skills. Some assignments are specifically intended to develop awareness and skills in IT, and others provide practice.

### 2.3.2 Michigan State University

Simple questions for the prospective students are posted on the website in order to confirm if undergraduate programme in mechanical engineering is right for them (Michigan 2014) considering their aptitude as shown in Appendix A.2.2. The students who answer 'yes' to these types of questions generally find mechanical engineering to be a good fit. Another question often asked is: "What type of career can a mechanical engineer pursue?". The website contains information for answering such questions. Mechanical engineering is such a broad field and covers fundamental principles that can be applied across many different disciplines, a graduate degree provides a student the opportunity to apply their knowledge and skills in a variety of different fields and industries. The university provides details of the fields where the alumni of the University of Michigan's mechanical engineering graduates are currently excelling: manufacturing, automotive, rail, aerospace, aviation, naval, electronics, robotics, consulting, and packaging, as well as the process, food, and chemical industries, just to name a few.

The Mechanical Engineering Programme is designed to prepare students for continued learning and for successful careers in industry, government, academia and consulting. Their alumni are expected to (Michigan 2014) :

1. Apply their engineering knowledge, critical thinking and problem solving skills in professional engineering practice or in non engineering fields, such as law, medicine or business.
2. Continue their intellectual development, through, for example, graduate education or professional development courses.
3. Embrace leadership roles in their careers.

The learning outcomes that the students must demonstrate at the end of the undergraduate programme is shown in Appendix A.2.3. The College of Engineering (COE) requires that every engineering student, regardless of their proposed engineering major, complete specific courses in the core subjects of mathematics, engineering, chemistry, and physics. As part of the above COE's core requirements, the Accreditation Board for Engineering and Technology (ABET) requires that all COE students complete 32 credits of non-engineering coursework in math and science during their undergraduate degree. As an engineer, it is important that he/she learns the technical concepts of their field, and also different areas of human accomplishment to better understand the impact of engineering solutions in a global, economic, environmental, and societal context. Under the Intellectual Breadth requirement, each student must select 16 credits of Intellectual Breadth courses in Humanities, Professional and Creative Development Courses (PCDC), Economics/Financials, and Liberal Arts Courses (LACs),

Within the Mechanical Engineering (ME) programme, there are a few additional categories of programme specific courses such as mechanical engineering core courses, technical electives, specialization electives, advanced math. The ME core courses consist of five major areas include Design and Manufacturing, Mechanics and Materials, Dynamics and Controls, Thermal Sciences, and Laboratories and Technical Communication with 45 credits. The programme provides an opportunity for the students to utilize all the skills taught in the ME programme to address real-world problems posed by industrial representatives, propose possible solutions to a problem, identify the best solution to build and test.

### 2.3.3 Purdue University's Engineering School

The undergraduate program mission is - "We educate tomorrow's engineering leaders and innovators, create new knowledge, provide a nurturing environment for a teamwork and lifelong learning, and impact the

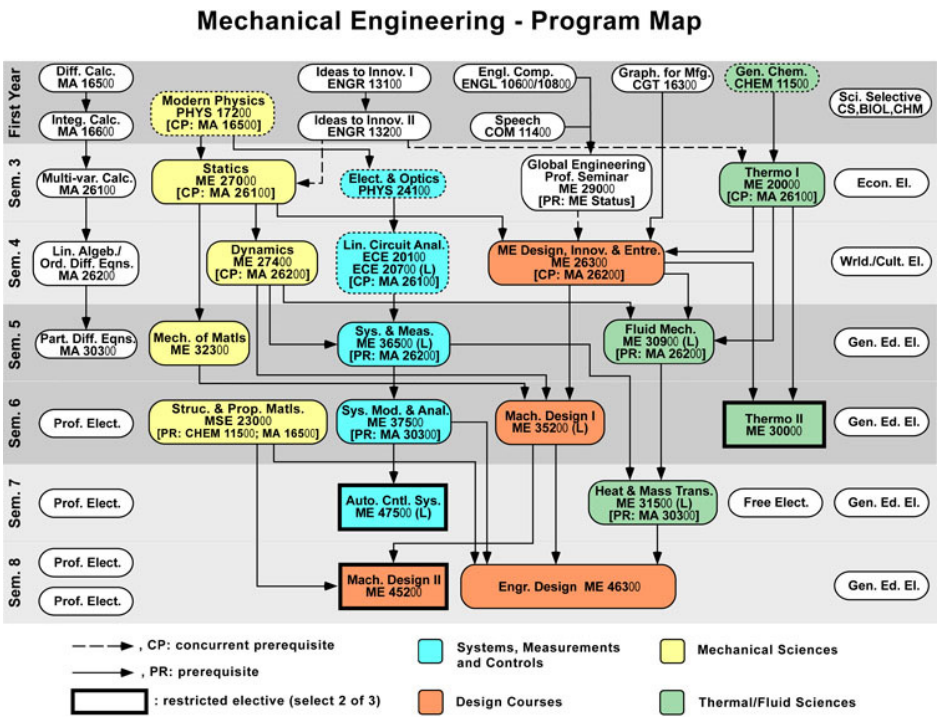
economic prosperity of our state, nation and world through learning, discovery and engagement" (Purdue 2014).

The Programme Educational Objectives of the School of Mechanical Engineering are to matriculate graduates who conduct themselves in a responsible, professional and ethical manner and who upon the years following graduation, are committed to demonstrating Discovery, Learning and Engagement (Appendix A.2.4).

Purdue engineers will be prepared for leadership roles in responding to the global technological, economic, and social challenges of the 21st century. The programme aims at three streams of skills, namely, engineering foundational skills, professional skills and emerging skills. Engineering foundation skills include engineering fundamentals, analytical, experimental, modern engineering tools and design skills. Professional skills include communication, teamwork, professional ethics & responsibility. Emerging skills include leadership, global engineering, innovation and entrepreneurship.

Purdue has established a programme map with clear linkages between several courses. The programme map helps in arranging the courses in the order in which they need to be learnt and also the pre-requisites for the key courses. In the programme map some of the courses are identified as concurrent pre-requisites and some courses are identified as pre-requisites. The courses are grouped and color coded for easy understanding (Figure 2.4). The groups of courses include

- System, measurements and controls
- Mechanical sciences
- Design courses
- Thermal and Fluid sciences




Source: (Purdue 2014)

**Figure 2.4 Course map**

### 2.3.4 MIT Engineering Leadership Programmes

Across the world, the mission statements of many undergraduate engineering degrees include aspirations such as '*… to produce engineering leaders for the 21st Century'* (Graham 2009). However, the majority of programmes appear to have no formal or articulated mechanism to deliver the leadership component of this goal, beyond (typically) student involvement in project- or problem-based learning activities. It appears that many of these are not coherent programmes designed for engineering students, but simply pull together a series of pre-existing modules from across the university with perhaps one additional team-based project at the end of the sequence.

The programmes of *engineering leadership education* have been specifically 'designed' tend to fall into one or more of the following categories (Graham 2009):

- Those based around leadership and management 'theory', often including a strong partnership with the institution's business school or 'leadership' centre
- Those based around team projects with a global, environmental or service focus
- Those involving 'coaching' of more junior students, usually in project teams
- Those involving industry-based 'real-world' projects, where the entire programme is funded through companies 'sponsoring' one or more team.

Three related trends were predicted for *engineering leadership education* in the future (Graham 2009):

**Global engineering**: Increasing focus on the students' ability to operate in complex, international multi-disciplinary teams, with a stronger awareness of national and cultural differences in their approach to engineering problems.

**Programme collaborations**: Greater development of cross-national partnerships between engineering leadership programmes, in part to offer students greater 'global' exposure.

**Self-analysis and reflection**: Awareness-building of the students' personal skill set, analysis of how this will impact their own leadership abilities and provision of a tailored programme to accommodate the students' individual development needs (Table 2.2).

**Table 2.2 Framework for self analysis and reflection**

| | |
|---|---|
| Core Values and Character | Initiative and decision making (responsibility, integrity, loyalty, self awareness, personal vision) |
| Sense making | Making sense of the world around us (the needs of society, system thinking, solution judgment) technology, |
| Relating | Developing key relationships and networks (listening and seeking compromise, communicating and advocating, wide connections, enterprise) |
| Visioning | Creating a compelling image of the future (tapping creativity, defining solutions, creating concepts) |
| Realizing the vision | Getting the job done (building a team, managing a project, innovating, inventing, implementing and operating) |
| Technical knowledge and critical reasoning | Grounding in the disciplinary fundamentals (problem solving, critical thinking, inquiry) |

Source: (Graham 2009)

### 2.3.5 Leaders' Thoughts on Education

Thoughts of some of the great leaders provide a holistic dimension about the and purpose of education.

Education is the manifestation of the perfection already in man (Vivekananda 2006). Knowledge is inherent in man, no knowledge comes from outside; it is all inside and what a man 'learns' is really what he 'discovers' by taking the cover off his own soul, which is a mine of infinite knowledge. Education must be such that character is formed, strength is increased, the intellect is expanded and by which one can stand on their own feet. The very essence of education is concentration of mind and few conditions to be a good disciple (Vivekananda 2006) are:

- Give up all desires for gain to learn the truth
- Disciple must be able to control the internal and external senses.

- Must have the greater power of endurance in good times and bad times.
- Conceive an extreme desire to be free.
- Faith, humility, submission, and veneration in the heart towards teacher

Pay as much attention to the means of work as to its end and in ninety-nine percent of cases, failure is caused because we did not pay attention to the means. The desired effect cannot be produced unless the causes are exact, proper and powerful (Vivekananda 2006).

Education has two aspects; the first is related to external and worldly education, which is nothing but acquiring bookish knowledge. The second aspect known as 'Educare', is related to human values (SaiBaba 2002). The word 'Educare' means to bring out that which is within. Human values are latent in every human being; one cannot acquire them from outside. They have to be elicited from within. Educare means to bring out human values. To 'bring out' means to translate them into action. Contrasts between 'Education' and 'Educare' (Saibaba 2014) are:

- Education can make a person 'great' ; 'Educare' makes a person 'good'.
- 'Educare' is academic excellence with character development
- 'Educare' is for life; Education is for living
- Education is outward and information oriented; 'Educare' is inward and transformation oriented
- Education sharpens our intellect; 'Educare' awakens our intuition

The object of basic education is the physical, intellectual and moral development of the children (Gandhi 1947). The emphasis laid on the principle of spending every minute of one's life usefully is the best education for citizenship and incidentally makes basic education self-sufficient. Education must bring out the best in the child and the man, in body, mind and spirit. Without being bookish, the student should adopt certain moral ethical codes like truth, nonviolence, charity and so on which will illumine his character.

Education should not become merely the acquisition of technical knowledge, but the understanding, with sensitivity and intelligence, of the whole problem of living. A 'disciple' is one who learns, not who conforms, not who obeys; he is the one who constantly learning (Krishnamurthy 2003). Conventional education makes independent thinking extremely difficult. Conformity leads to mediocrity. If we are being educated merely to achieve distinction, to get a better job, to be more efficient, to have wider domination over others, then our lives will be shallow and empty. The highest function of education is to bring an integrated individual who is capable of dealing with life as a whole and another function of education is to create new values (Krishnamurthy 1992).

The right kind of education begins with the educator, who must understand himself and be free from established patterns of thought. To educate the educator – that is, to have him understand himself – is one of the most difficult undertakings in view of crystallised system of thought or a pattern of action or some ideology, to a religion, or to a particular standard of conduct. Parents are eager to have their child educated to hold secure positions, or to marry well. Contrary to what is generally believed, most parents do not love their children, though they talk of loving them. People who are rigorously trained to be lawyers or doctors, may become parents without undergoing any training whatsoever to get them for this all-important task. Being absorbed in

their own problems, many parents shift to the teacher the responsibility of the wellbeing of their children; and then it is important that the educators help in the education of the parents as well (Krishnamurthy 1992).

Science and technology are a dialogue of the human spirit with nature. Literature and art are a dialogue of the spirit with oneself. Philosophy and religion are a dialogue of the sprit with the supreme mastery which underlies the universe (Radhakrishnan & Renewed 2009). When people speak of a conflict between science and religion, they do not appreciate the spiritual character of science and the rational character of religion. When properly understood, science and religion help each other. We have to combine ancient tradition with modern knowledge. If we wish to have an open society, we should have open minds. For social and national integration, for increasing productivity, education should be properly utilized. The importance of education is not only in knowledge and skill, but it is to help us to live with others (Radhakrishnan & Renewed 2009). One must attach importance to observation, experiments and the relationship of nature and society in the method of teaching.

Rabindranath Tagore believed that the principal means of effective and sustained change would come through education, and therefore, it was important to think seriously and deeply about its nature and form of education (Bhattacharya & Tagore 2014). The emphasis here was on self-motivation rather than discipline, and on fostering intellectual curiosity rather than competitive excellence. Tagore emphasized that the purpose of education was consonant with full realization of the entire purpose of human life and educational philosophy must address: education of the body and senses; education of the inellect, education of the sprit, and cultivation of feeling; education of nature; education and internationalism/universalism and education for the extension of self.

- Education of the body includes, physical fitness, physical exercise, training of the senses and efficiency and skills. Physical fitness is a prerequisite of mental fitness.

- Education of the intellect includes a constant curiosity and alertness, a scientific and rational outlook and independence of thinking. Use of knowledge and generation of knowledge are two aspects of intellectual goals.

- Education of spirit pertains to ethics and spirituality and the belief that there is a universal sprit that links and permeates all life and objects.

- Education for internationalism/universalism aims at education for fullness to be achieved in and through the entire humanity.

- Education for extension of self. includes the idea of the application of knowledge as well as attitudes ensuring sympathy and empathy. Tagore believed that our deep satisfaction lies in a relationship which is not based on any selfish consideration.

Tagore believed in education through participation of students in creative and constructive activities of arts, dance, and music; reading of literature and dramatic performances; functions and festivals, training in craft and handicraft and through social service concurrent with academic learning (Bhattacharya 2014). The joy of learning was another most valuable principle in Tagore's educational method, as he felt that joy was important for the wholesome growth of children, both in body and mind.

Personal mastery goes beyond competence and skills, though it is grounded in competence and skills. It goes beyond spiritual unfolding or

opening, although it require spiritual growth. It means approaching one's life as a creating work, living life from a creative as opposed to reactive viewpoint. Learning does not mean acquiring more information, but expanding the ability to produce results we truly want in life. It lifelong generative learning. People with personal mastery have a special sense of purpose, they have learned how to perceive and work with forces of change rather than resist those forces. They are deeply inquisitive, and are committed to continually seeing reality much more accurately, they feel get connected to others and to life itself (Senge 1990).

Life education can be seen as being more holistic and evolving, enabling better integration. 'Life education' facilitates the ability to be context sensitive. Life education builds the inner consciousness to make a choice that is value adding, aims at facilitating the deepest level of discrimination and enables the person to be appropriate to a given context. 'Life education' teaches one to work at a cause level. The learning from life and the beliefs that one makes in life governs a person's behavior and shows a path to handle issues in life at a 'belief' level rather than at a 'behavior' level (Kalpana 2008).

### 2.3.6 Bloom's Taxonomy

While a great deal of school education in India is oriented to rote learning, engineering is all about understanding and application of science and mathematics.

Taxonomy is a framework in which educational objectives are organised in a continuum. The statement of an objective contains a verb and a noun where the verb describes the intended cognitive process dimension and the noun describes the knowledge students are expected to acquire or construct (Anderson 2001). An example - "The student will learn to

distinguish (the cognitive process) among non-federal, federal, and unitary systems of government (the knowledge)".

Four categories of knowledge dimensions, namely, Factual, Conceptual, Procedural, and Meta-cognitive are arranged in a row on the Taxonomy Table (Table 2.3). These categories are assumed to lie along a continuum from concrete (factual) to abstract (Meta-cognitive). Six dimensions of cognitive learning such as Remember, Understand, Apply, Analyze, Evaluate, and Create, are arranged in the columns of the Taxonomy Table (Table 2.3). The six dimensions represent the cognitive complexity; that is, 'Understand' is believed to be more cognitively complex than 'Remember'. 'Apply' is believed to be more cognitively complex than 'Understand' and so on.

**Table 2.3 Cognitive process and knowledge dimensions**

| | Cognitive process dimension | | | | | |
|---|---|---|---|---|---|---|
| Knowledge dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
| Factual | | | | | | |
| Conceptual | | | | | | |
| Procedural | | | | | | |
| Meta-Cognitive | | | | | | |

Source: (Anderson 2001)

Knowledge dimensions are described as follows:

- *Factual knowledge* contains the basic elements students must know if they are to be acquainted with the discipline or be able to solve any of the problems in it.

- *Conceptual knowledge* includes knowledge of categories and classification and relationships between and among them – more complex, organized knowledge forms. *Conceptual knowledge* include schemas, mental models, or implicit or explicit theories in different cognitive psychological models.

- Procedural knowledge is the "knowledge of how" to do something. The "something" might range from completing fairly routine exercises to solving novel problems. Procedural knowledge often takes the form of a series or sequence of steps to be followed. It includes knowledge of skills, algorithms, techniques, and methods, collectively known as procedures.

- Metacognitive knowledge is knowledge about cognition in general as well as awareness of and knowledge about one's own cognition.

Sub types and examples of knowledge dimensions are shown in Table 2.4.

**Table 2.4 Knowledge dimensions and examples**

| Knowledge dimension | Subtypes | Examples |
|---|---|---|
| Factual Knowledge | Knowledge of terminology | Knowledge of alphabets, Knowledge of scientific terms |
| | Knowledge of specific details and elements. | Knowledge of major facts about particular cultures and societies, Knowledge of practical facts important to health. |
| Conceptual knowledge | Knowledge of classification and categories | Knowledge of the variety of types of literature, Knowledge of various forms of business ownership |
| | Knowledge of principles and generalizations | Knowledge of major generalizations about particular cultures, Knowledge of the fundamental law's of physics |
| Meta-Cognitive | Knowledge of theories, models, and structures. | Knowledge of the interrelationships among chemical principles as the basis for chemical theories, Knowledge of overall structure of organizations |
| Procedural knowledge | Knowledge of subject - Specific skills and algorithms | Knowledge of skills used in painting with water colors |
| | Knowledge of subject - Specific techniques and methods | Knowledge of research methods relevant to the social sciences, Knowledge of techniques used by scientists in seeking solutions to problems |
| | Knowledge of criteria for determining when to use appropriate procedures. | Knowledge of the criteria for determining which of several types of essays to write, Knowledge of the criteria for determining which method to use in solving algebraic equations |
| Meta-Cognitive | Strategic knowledge | Knowledge that rehearsal of information is one way to retain the information, Knowledge of elaboration strategies such as paraphrasing and summarizing |
| | Knowledge about cognitive tasks | Knowledge of recall tasks (i.e short answer items), memory systems, recognition, and tasks (i.e multiple-choice items) |
| | Self-knowledge | Knowledge that one is knowledgeable in some area and not in others, Knowledge that one tends to rely on one type of "cognitive tool" |

Source: (Anderson 2001)

Description of each of the cognitive processes dimensions are as below:

- Remember: Remembering involves retrieving relevant knowledge from long term memory. The two associate cognitive processes are *recognizing* and *recalling*.
- Understand: Learners are set to understand when they are able to construct meaning from instructional messages including oral, written, and graphic communication. They are able to build connections between the 'new' knowledge to be gained and their prior knowledge. Cognitive processes in the category of '*Understand*' include *interpreting, exemplifying, classifying, summarizing, inferring, comparing,* and *explaining*.
- Apply: *Apply* involves using procedures to perform exercises or solve problems. Thus, *Apply* is closely linked with *Procedural knowledge*. The *Apply* category consists of two cognitive processes – *Executing* – when the task is an exercise (familiar) – and *Implementing* – when the task is a problem (unfamiliar).
- Analyse: *Analyse* involves breaking materials into this constituent parts and determining how the parts are related to one another and to an overall structure. This process category includes the cognitive processes of *differentiating*, *organizing, attributing*.
- Evaluate: *Evaluate* is defined as making judgements based on criteria and standards. The criteria most often used are quality, effectiveness, efficiency, and consistency, which may be either qualitative or quantitative. The category *Evaluate*

includes the cognitive processes of *checking* (judgments about the internal consistency) and *critiquing* (judgements based on external criteria).

- Create: *Create* involves putting elements together to form a coherent or functional whole. Objectives classified as *Create* have learners make a new product by mentally re-organising some elements or parts into a pattern or structure not clearly present before. The processes involved in *Create* are generally co-ordinated with the students' previous learning experiences. The creative process can be thought of as starting with a divergent phase in which a variety of possible solutions are considered as the student attempts to understand the task (*generating*). This is followed by a convergent phase in which the student devises a solution method and turns it into a plan of action (*planning*). Finally, the plan is executed as the student constructs the solution (*producing*).

The four most important aspects of Bloom's Taxonomy are learning, instruction, assessment and alignment are used for organizing the Education & Training programme.

### 2.3.7 Instructional Design Methodology

The instructional design must be aimed more at aiding the process of learning than the process of teaching and, also at 'intentional' learning as opposed to 'incidental' learning (Gagné 2005). This implies that the target goals and desired learning outcomes guide the design and selection of learning activities. Five major variables that affect the degree of learning attained by a student are learner perseverance, time allocated, quality of instruction, aptitude and student's ability to learn. Instructional design can be

an individual effort, or on a large scale project, it can involve a team of designers, subject matter experts, evaluation experts, and production personnel.

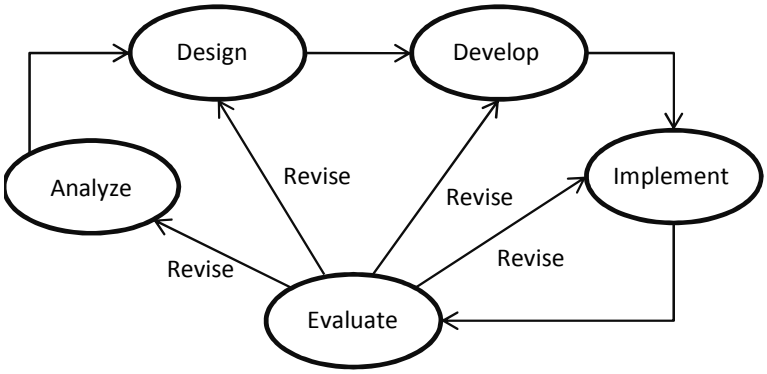
Instructional design is an iterative process and needs to consider learners as an active part of the process. Learning effectiveness against the objectives is checked and the same is used to revise the instruction continuously. Instructional design itself is a process consisting of a number of identifiable and related sub-processes. It could be simple with learning outcomes, instructional methods and student assessments. The external events are called instructions, and they must align with the internal events to support the different stages in the process. Stimulation to gain attention to ensure the reception of stimuli can be achieved by:

- Informing learners of the learning goals to establish appropriate expectations
- Reminding learners of previously learned content for retrieval from long term memory
- Clear and distinctive presentation of material to ensure selective perception
- Guidance of learning by suitable semantic encoding
- Eliciting performance, involving response generation
- Providing feedback about performance
- Assessing the performances involving additional response feedback occasions
- Arranging a variety of practice to aid future retrieval and transfer

Training systems focus primarily on skills development whereas the educational systems focus is more on generalized intellectual development and personal competence. Instructional Systems Design (ISD) is the process for creating instructional systems. It is both systematic and scientific, in that it is documentable, replicable in its general application, and leads to predicable outcomes. Yet it requires creativity in identifying and solving instructional problems. Five kinds of learned capabilities needs to be kept in mind for creating instructional system design (Gagné 2005):

- Intellectual skills which permit the learner to carry out symbolically controlled procedures using discriminations, concepts, rules, and problem solving skills
- Cognitive strategies: The means by which learners exercise control over their own learning processes
- Verbal informatics: the facts and organized "knowledge of the world" stored in the learner's memory
- Attitudes: The internal states that influence the personal action choices a learner makes
- Motor skills: the movements of skeletal muscles organized to accomplish purposeful actions

ADDIE is one of the common instruction design methodologies used. ADDIE has five steps such as Analyze, Design, Development, Implement and Evaluate as shown in Figure 2.5. *Analyze* involves formal/informal needs assessment to determine goals and objectives of the learning programme. *Design* is to determine the content, delivery and evaluation method appropriate to the goals and objectives. *Development* is to create the teaching and learning content (including evaluation formats) for implementation. *Implementation* involves the delivery of the content to the target audience and *Evaluation* is verifying the results against the objectives.




Source: (Gagné, 2005)

**Figure 2.5 ADDIE model for instructional design**

Summary of five steps of ADDIE (Gagné, 2005)are:

- Analysis: The first step is to determine the needs for which instruction is the solution, then conduct an instructional analysis to determine the target cognitive, affective, and motor skill goals for this course, determine what skills the students are expected to have, and which will impact learning in the course, Analyse the time available and how much might be accomplished in that period of time including a context or resource analysis.

- Design: Translate course goals into performance outcomes, and major course objectives (unit objectives), determine the instructional topics or units to be covered, and how much time will be spent on each, sequence the units with regard to the course objectives, Flesh out the units of instruction, identifying the major objectives to be achieved during each unit, Define lessons and learning activities for each unit, Develop specifications for assessment of what students have learned.

- Development: Make decisions regarding the types of learning activities, prepare draft materials and/or activities, try out materials and/or activities, revise. refine, and produce materials and activities, produce teacher training or adjunct materials.

- Implementation: Share the materials for adoption by teachers or students, provide help or support as needed.

- Evaluation: Implement plans for student evaluation, programme evaluation and for course maintenance and revision

Learning evaluation is carried out in four levels - Level 1: Reaction, Level 2: Learning, Level 3: Behavior, Level 4: Results in sequence (Kirkpatrick et al 2008). Each level has an impact on the next level. Like the continuum seen on cognitive dimensions on Bloom's Taxonomy, the process becomes more difficult and time consuming as we move up from one level to another. Description of the four levels is given below :

- Reaction is about how the participants of a teaching/training programme react to it. Positive reaction may not ensure learning but negative reaction almost certainly reduces the possibility of learning occurring. This is verified by collecting feedback at the end of training session.

- Learning is the extent to which the participants improve their knowledge, skill or attitude as a result of attending a programme. Learning is verified using tests and examinations after the programme.

- Behaviour is the extent to which change in behaviour has occurred in the workplace because the participant attended the training programme.

- Results can be defined as the final results or impact realized due to the contribution made by the participants based on the application of their learning.

### 2.3.8 Summary of Insights from Section 2.2

- Education enables full realisation of the entire purpose of human life by expanding ability to produce results towards the goal. Hence, it must address the following : life-building, man-making, character-making, concentration of mind and assimilation of ideas.

- Teachers need to be clear about what they want to teach, and what they exactly mean by teaching.

- Parents need to go through a formal training to be effective parents so that their children realise full potential of education.

- Philosophy of the curriculum needs to focus on specific occupations in order to develop 'work-ready' engineers with 'occupation-specific competencies'. Education must strike a balance between disciplinary knowledge and professional skills such as effective communication, teamwork, leadership, business knowledge, entrepreneurship, and project management.

- Need to establish a structured process leveraging instructional design and Bloom's Taxonomy to determine the competencies for the target roles, deploy competencies into learning outcomes, classify the learning outcomes by knowledge

dimensions and cognitive process dimensions guide the content and selection of appropriate teaching / learning methodology and evaluation.

- Undergraduate programmes were benchmarked for offering the following unique features:
    - Simple questions for prospective students to verify their aptitude for engineering and career orientation with choice of sectors and roles.
    - Clearly articulated mission and programme objectives – both technical and professional.
    - Judicious mix of lectures, tutiorials, practical work etc.
    - Wide choice of elective streams for specialisation.
    - Individual and group projects some of them Industry sponsored with the opportunity to develop professional skills.
- A Programme map is established to show the linkages between several courses in different years.

## 2.4 Enterprise Management System and Competence of Organizations

Successful companies like Toyota, GE and Canon has evolved an enterprise management system that articulated their vision of the future, values, business and management processes. Competencies at employee level are integrated with the enterprise management system. The consistent understanding and practice across all the levels of the organization over long periods leads to a culture which produces significant business impact in these

organizations over decades. Indian organizations have to close large gaps in their performance with reference to their global leaders in the market. Hence understanding this framework is relevant to evolve a similar system. Towards this, literature survey is done for the following areas:

- Core competence of an organization
- Learning organization
- Knowledge management
- Toyota way
- GE way
- Canon production system
- Systems approach

### 2.4.1 Core Competence of Organizations

Core Competence is a bundle of skills and technologies rather than a single discrete skill or technology (Hamel 1994). Core competence represents the sum of learning across individual skill sets and individual organizational units and hence is very unlikely to reside in its entirety in a single individual or small team (Hamel 1994). A medium sized company or a business would involve 40-50 competencies. The team needs to have a good understanding of the entire hierarchy of competencies from meta competencies (package tracking), to constituent skills (bar coding). In any case, to actually manage a firm's stock of core competencies, its top management must be able to disaggregate core competencies into their components, all the way down to the level of specific individuals with specific talents.

What was a core competence in one decade may become a mere capability in another. For example, in the 1970s and 1980s quality, as

measured by defects per vehicle, was undoubtedly a core competence for Japanese car companies. Superior reliability was an important value element for customers and a genuine differentiator for Japanese car producers. But today, other companies have bridged this gap with their Japanese counterparts on quality and reliability.

### 2.4.2 'Learning Organization'

The organizations that will truly excel in the future will be the organizations that discover how to *tap people's commitment and capacity to learn at all levels in the organization* (Senge 1990). Five disciplines of learning organizations (Senge 1990)are:

**System Thinking:** A body of knowledge and tools that has been developed over the past fifty years, to make the full patterns clearer, and help to see how to change them effectively. For example, understanding the system of a rainstorm by contemplating the whole in terms evaporation of water, cloud masses, darkening, raining, flow of water miles away etc. All the events are distant in time and space and yet all are connected within the same pattern.

**Personal Mastery:** Discipline of continually clarifying and deepening our personal vision of focusing our energies, of developing patience, and of seeing reality objectively. It is an essential cornerstone of the learning organization – the learning organization's spritual foundation. People with a high level of mastery are able to consistently realise the results that matter most deeply to them – in effect, they approach the life as an artist would approach a work of art.

**Mental Models:** Discipline of turning the mirror inward, learning to unearth our internal pictures of the world, to bring them to the surace and hold them rigourously to scrutiny. It also includes the ability to carry on 'learningful'

conversations that balance inquiry and advocacy, where people expose their own thinking effectively and make that thinking open to the influence of others.

**Building Shared Vision:** One's idea about leadership that has inspired organizations for thousands of years, it's capacity holds a shared picture of the future we seek to create.

**Team Learning:** Learning by the teams that produce extraordinary results, but the individual members are growing more rapidly that could have concurred otherwise. The discipline of team learning starts with 'dialogue', amongst the members of a team by suspending assumptions and enter into a genuine 'thinking together'. Team learning is vital because teams, not indivduals are the fundamental learning units. Unless the teams learn, organizations cannot learn.

### 2.4.3 Knowledge Management:

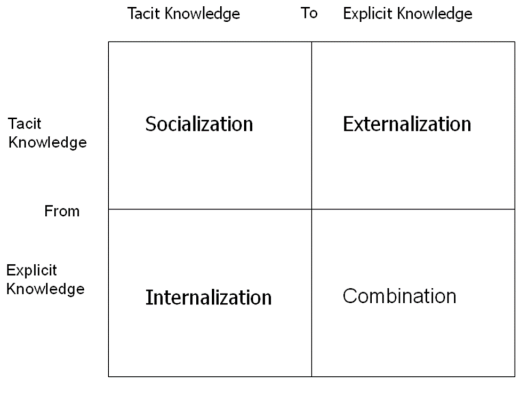
When markets shift, technologies proliferate, competitors multiply, and products become obsolete almost overnight, the companies that consistently create new knowledge remain successful (Nonaka 1995). These companies disseminate the knowledge widely throughout the organization, and quickly embody it in new technologies and products. These activities define the "knowledge-creating company", whose sole business is continuous innovation. Some of the highly successful Japanese competitors like Honda, Canon, Matsushita, NEC, Sharp and Kao have become famous for their ability to respond quickly to customers, create new markets, rapidly develop new products, and dominate emergent technologies. The secret of their success is their unique approach to managing the creation of new knowledge (Nonaka 1995). Generally, the knowledge expressed explicitly represents the tip of the iceberg with rest of the knowledge being primarily 'tacit' – something not easily visible and expressible. Tacit knowledge is highly

personal and hard to formalize, making it difficult to communicate or to share with others.

Tacit knowledge can be segmented into two dimensions (Nonaka 1995):

- Technical dimension, which encompasses the kind of informal and hard-to-pin-down skills or crafts captured in the term 'Know-how". Master craftsman with wealth of expertise unable to articulate the scientific or technical principles behind what he knows.
- Cognitive dimension, which consists of schemata, mental models, beliefs, and perceptions which shape the way we perceive the world around us.

Tacit knowledge and Explicit knowledge are mutually complementary entities and interact with and interchange into each other in the creative activities of human beings. Knowledge is created through the interaction between tacit and explicit knowledge and hence it allows four different modes of knowledge conversion (Figure 2.6).

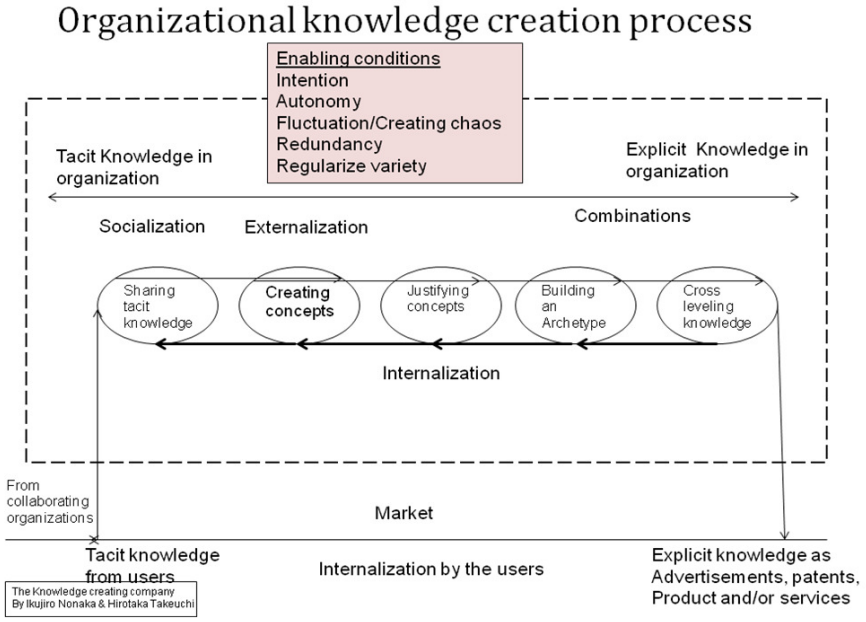



Source: (Nonaka 1995)

**Figure 2.6 Four modes of knowledge conversion**

- Socialisation (From Tacit to Tacit): Process of sharing experiences and thereby creating tacit knowledge such as shared mental models and technical skills.
- Externalisation (From Tacit to Explicit): Externalisation is a process of articulating tacit knowledge into explicit concepts.
- Combination (From Explicit to Explicit): Combination is a process of systemising concepts into knowledge system.
- Internalisation (From Explicit to Tacit): Internalisation is a process of embodying explicit knowledge into tacit knowledge. It is closely related to "Learning by doing".

Organization knowledge creation is a continuous and dynamic interaction between tacit and explicit knowledge, which uses all four modes of knowledge conversion (Figure 2.7).




Source: (Nonaka 1995)

**Figure 2.7 Organizational knowledge creation process**

There are five conditions to promote the knowledge creation (Nonaka 1995):

- Intention: Organization's aspiration to its goals - A vision about what kind of knowledge should be developed.
- Autonomy: All members of an organization act autonomously as far as circumstances permit, in order to motivate themselves to create new knowledge.
- Fluctuations and Creative Chaos: Fluctuation and Chaos due to a crisis such as sudden decline in performance due to changes in the market stimulate the interaction between the organization and external environment. It can also be generated intentionally when organization's leaders try to evoke a 'sense of crisis' among organizational members by proposing challenging goals.
- Redundancy: Redundancy of information speeds up knowledge creation process.
- Requisite variety: Members possessing required variety can cope with many contingencies which can be enhanced by combining information differently, flexibly, and quickly by providing equal access to information throughout the organization.

### 2.4.4 Toyota Way

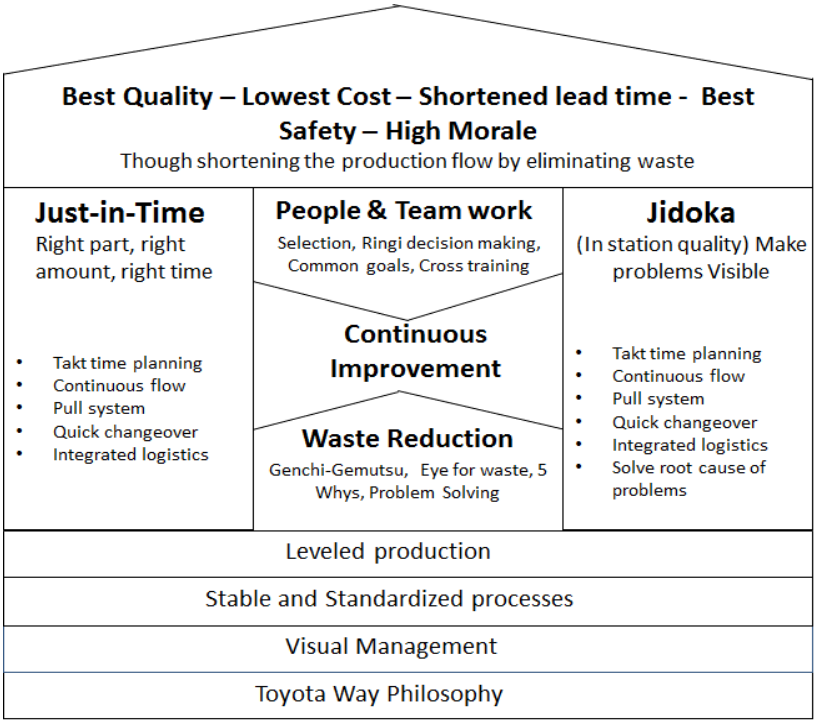
Thaichi Ohno was the architect of the Toyota Production System which paved the way for establishing and institutionalizing the Toyota Way. The basis of the Toyota production system is the absolute elimination of

waste with two pillars needed to support the system – Just-in-time and Autonomation (Ohno 1988) :

- Just-in-time: Just-in-time means that in a flow process, the right parts needed for assembly reach the assembly line at the time they are needed and only in the amount needed.
- Autonomation: Autonomation changes the meaning of management as well. An operator is not needed while the machine is working normally. Only when the machine stops because of an abnormal situation does it get human attention. As a result, one worker can attend to several machines thus increasing production efficiency.

The operating method of the Toyota production system is '*Kanban*' by which all the movements in the plant could be systemized or unified. Kanban accelerates improvements in the plant and supply chain.

Business organization is like the human body. The human body contains autonomic nerves that work without regard to human wishes and motor nerves that react to human command to control muscles (Ohno 1988). In a production plant, autonomic nerve means making judgments autonomously at the lowest possible level; i.e for example, when to stop production , what sequence to follow in making parts, or when over time is necessary to produce the required amount. These decisions can be made by the factory workers themselves, without having to consult the production control or engineering department. The larger a business, the better reflexes it needs.




Source: (Liker 2004)

**Figure 2.8 Toyota production system**

Fuji Cho, a disciple of Taiichi Ohno developed a simple representation of the Toyota Production System (TPS) as shown in Figure 2.8 is for all their stakeholders. It starts with the goals of best Quality, lowest Cost, shortest Lead time, best safety and high Morale in the roof. There are two outer pillars – *Just-in-time* and *Jidoka. Just-in-time* means right part, right amount, right time. *Jidoka* means 'autonomation' which is automation with human touch. In the centre of the continuous improvement with people and team work on one side and waste reduction on other side. Finally there are various foundational elements, which include leveled production, stable and standardized process, visual management, and Toyota way philosophy (Liker 2007).

Toyota Production System requires highly capable people to maintain and continually improve it. Merely installing methods without the

appropriate development of skills and abilities will produce limited benefits, and the primary purpose of the system itself – namely increased performance through the increased capability of people apply. It requires a dedication to personal change and the realization that only through facing adversity and hardship will the true benefits be achieved (Liker 2004).

### 2.4.5 GE Way

Jack Welch articulated and implemented a set of business strategies over two decades and succeeded beyond his wildest imagination (Slater 2000). GE Way can be defined as the evolution of those business strategies and cultural change that Welch has engendered at the company. The strategies drove cultural change in the organization with time and with a different intensity of change. With success of low intensity change, GE could succeed in implementing high intensity change (Slater 2000). For example, Six Sigma was one of the high intensity initiatives which brought significant cultural change and business impact over a long period of time. Some of the strategies implemented progressively over years by Welch are shown in the Appendix A.2.5.

Welch believed that an effective leader must possess five qualities which he later defined into four values. They are Energy – Enormous personal energy & strong bias for action, Energizer – Ability to motivate and energise others, Infectious Enthusiasm - maximize organization potential, Edge – Competitive spirit, instinctive drive for speed/impact, strong conviction and courageous advocacy and Execution – Deliver results.

GE established a management system with critical milestones fixed to the annual calendar. All the time tested strategies were developed into practices which were embedded in the GE management system. Some of the milestones of the GE management system include - Worldwide product plan

during the second quarter, Session 1: Strategy during third quarter, Session 2 : Operating plan during fourth quarter, Session C : Organization during first quarter and Session D : Compliance during fourth quarter.

Of these milestones, Session C relates to organization and people. Session C is an embedded management process, both bottom up and top down with minimal ceremony and papers, highly interactive and serves as a basis for the CEO to allocate resources in terms of funds, people and technology. Crotenville basically runs courses for leadership at several levels built around the GE competency model. As shown in Appendix A.2.5, the courses that are offered on nomination are decided during Session C. Welch used to visit Crotenville twice a month, lecturing to GE executive, and mingling at receptions for more informal one-on-one conversations.

Thus, the GE's management system were evolved and institutionalized over two decades, making GE one of the most admired companies in the world.

### 2.4.6 Canon Production System

Ryuzaburo Kaku, President of Canon set a mission to move away from the kind of hardware thinking that relies heavily on products towards something like software thinking, which emphasizes the structure of operations (Japan Management Association 1987). Software thinking involved simplification of Canon's complex production system of interlocking and interdependent factories and creation of a new organizational framework based on product groups in order to build strength by creating areas of interdependent responsibility as well as expertise. Three management systems were established to help make the changes and coordinate common functions in all areas of the company, which were, the Canon Production

System (CPS), the Canon Development System (CDS), and the Canon Marketing System (CMS).

The development system was to foster the development of new products high in performance and quality, matched to consumer needs and timed for the market. The production system was to eliminate waste so that the company could manufacture higher-quality products at lower costs and withstand both stronger yen and intensified competition. The marketing system was to expand and strengthen Canon's independent domestic and overseas sales network by building a high quality service and sales force.

The (Japan Management Association 1987), lists the most popular fundamentals of the four Canon principles that emphasise the three fold sprit of self: Self-motivation, Self-respect, and Self-reliance. This philosophy of Canon fosters an open, supportive environment along with a strong sense of duty, purpose, and responsibility. Keeping everyone informed about CPS operations and activities is not easy. Courses in CPS basic operations must be taught continuously. Improvement techniques developed and applied successfully in one work centre must be made available to others. Hence, more efficient and standardized methods of communication and training were developed. The essential team approach is emphasized in every Canon training programme along with methods and practical activities to promote goal achievement. Canon training was seen as an opportunity for self-development – an independent source of vitalization within the workplace.

Training curricula were standardized according to the following principles (Japan Management Association 1987):

- To ensure a human resources development programme aimed at all personnel, clarify requirements and eliminate inequalities in training opportunities.

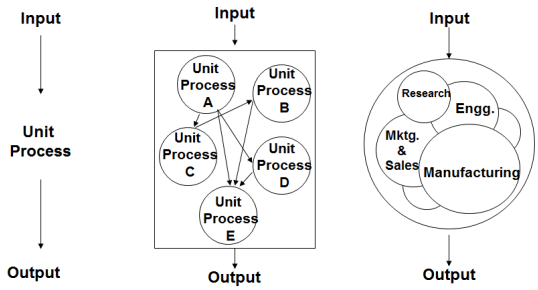
- Since training is handled independently at each factory according to its needs, draw up guidelines to set consistent levels for training.
- Wherever possible, incorporate the strengths of existing programmes into new standards (particularly on-the-job training).
- Make sure everyone understands that human resources development is a continuous process.

### 2.4.7 Systems Approach

Systems thinking is the discipline of seeing the whole, it is a framework for seeing interrelationships rather than things and for seeing patterns of change rather than static 'snapshots' (Senge 1990). It is a set of general principles – distilled over the course of the twentieth century, spanning fields as diverse as physical and social sciences, engineering, and management. It is also set of specific tools and techniques, originating in two threads; in 'feedback' concepts of cybernetics and in 'servo-mechanism' engineering theory dating back to the nineteenth century. Today, systems thinking is needed more than ever because we are becoming overwhelmed by complexity. Perhaps for the first time in history, humankind has the capacity to create far more information than anyone can absorb, to foster far greater interdependency than anyone can manage, and to accelerate change far faster than anyone's ability to keep pace. The essence of the discipline of systems thinking lies in a shift of mind in:

- Seeing interrelationships rather than linear cause-effect chains
- Seeing process of change rather than snapshots

According to (Subramanian 2000), every organization may be perceived as a unique combination of unit processes. Employees in any industrial activity may be responsible for unit processes, organizations, or enterprises depending upon their job function. Every activity of any individual, organization, or enterprise can be treated as an input/process/output sequence as shown in Figure 2.9. The process without clear understanding is often treated as 'Black Box'. Such a black box approach is also the reason for gradual erosion of the long term viability of any enterprise or industry. There is a different, perhaps more appropriate, approach to describe the input/process/output sequence of any problem, job, or activity of an individual, organization, or enterprise which is called the "System Approach" (Subramanian 2000).

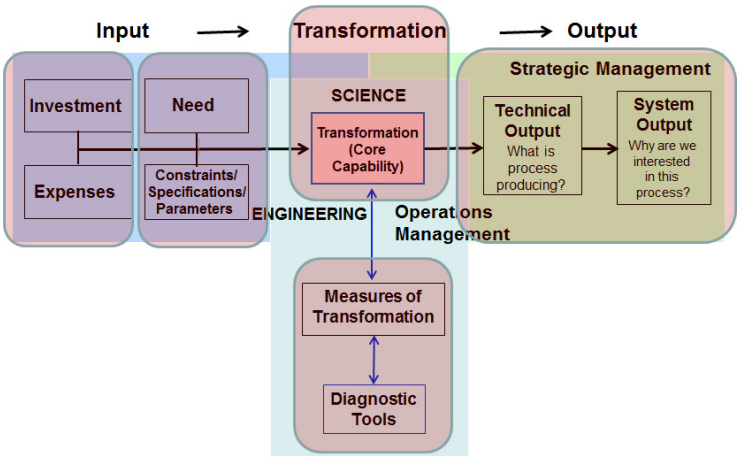



Source: (Subramanian 2000)

**Figure 2.9 Systems approach for individuals, organisaiton and enterprise**

In the global economy, every job at every level of the organization becomes a 'system' through integration of multiple tasks (Subramanian 2000). Every enterprise may be thought of as a system with a large number of inputs. The transformation between the inputs and outputs is the 'process' of the enterprise. The 'process' is frequently recognized through a set of measures of process called 'macroscopic process variables'. In the global economy, this focus on individual factors is being replaced by a need to focus on a group of factors or the individual input categories. The output of the process can be classified as technical output and system output. Technical

outputs are readily obvious to those who are internal to or are active participants in the process and its day-to-day details. The traditional description of any enterprise is largely limited to technical outputs or internal performance measures of the enterprise. System outputs are the output factors readily discernible to those who benefit from the process and its existence. The systems output is integrally linked to the technical output of the process. Yet, the two are not the same. They are linked to each other through definite causal relations, called 'external causal relations', that are governed by factors outside the process.




Source: (Subramanian 2000)

**Figure 2.10 Systems approach for professional solutions**

### 2.4.8 Summary of Insights from Section 2.3

- Organizations have to acquire sustainable competitive advantage by building and leveraging their "Core Competence" which is a bundle of skills and technologies.
- Towards enhaning learning across indiviual skill sets and orgaisational, five disciplines of the learning organization

System Thinking, Personal Mastery, Mental models, Building Shared Vision, and Team learning can be a powerful. .

- Companies remain successful by consistently creating and disseminating new knowledge widely throughout the organization as well as embedding it in new technologies and products.

- Successful global organizations established a holistic enterprise management system by integrating business processes like production, product development and marketing. Such initiatives led to a major cultural transformation in these organizations and development of people through a structured training around their enterprise management system.

- Systems thinking is the framework for seeing interrelationships rather than things, for seeing patterns of change rather than static 'snapshots'.

- Every activity of any individual, organization, enterprise can be treated as an input/process/output sequence with a large number of inputs, the transformation between the inputs and outputs - technical outputs and system outputs.

## 2.5 SUMMARY OF IDEAS FOR RESEARCH

From the literature survey, the following insights were considered for developing the research methodology:

- Assessment centre approach for selection of entry level employees based on Innate ability - traits, motive and attitude can be used for selection and role fitment.

- Structured process for role and competency based development of employees – focus on functional and behavioural competencies.
- Structured process for a holistic competency based engineering education programme co-created with stakeholders – focus on aspiration, functional competencies, professional skills and life skills
- Framework for enterprise management system – integrating competencies of individuals with business processes, management processes, vision and culture.
- Embed system thinking in the processes and framework – focus on input, measures of transformation, technical and system outputs.